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Who controls development

ABSTRACT

Every country accepts a central control system for the national grid, but opinions have been divided as to who controls development of the grid. A benefit of a grid as a monopoly structure is that one organisation and government assisted funding enables grid development for the national good – even if there is no immediate return on the investment.

KEYWORDS

national grid development, monopoly grid structure, capital investment

1. Grid development and barriers to growth

It seems to have come as a great surprise to many during the last few years that the U.S. grid structure was beginning to fall apart after years of rising load and lack of capital investment. This current state of affairs really should not have been earth-shattering news to anyone. In a country where free enterprise and capitalism are at the root of every business and the ethos has always been *profit first*, why should a corporation invest hard earned capital into unprofitable activities?

Despite initial warnings, prompting, dire warnings and eventually pleadings from various reliability councils, policy makers and commentators, meaningful levels of investment have been very slow to emerge. There have been various theories put forward as to why this has happened, including lack of oversight, planning difficulties – strategic and routing issues, lack of regulation and too much regulation; but there are more fundamental structural issues that have impacted the industry.

In the early days of electrification in the 1900s electricity generation and distribution was developed on a local municipal basis much as the gas industry some years earlier. This was funded either by entrepreneurial capital, co-operative funding or town civil administration; the point being that in densely populated areas it was profitable to install a generator and cable to houses and sell electricity to the townsfolk. The networks then radiated and expanded to include more consumers to a point where the population density fell and it became uneconomic to install distribution network for a few additional consumers. This was the nature of development in every industrialised nation including the U.S., U.K. and other European countries. As neighbouring communities expanded, their networks overlapped and the second wave of development began; municipal companies merged, voltage levels increased, networks became more complex and rather than a radial topography extending along communication routes, proper grid networks were developed that we recognize today. Electrical equipment supply companies developed specialist capabilities in supplying switchgear, transformers, cables, overhead lines, substations, etc. with names that reflected their ability to supply all electrical equipment: GE - General Electric in the U.S., GEC - General Electric Company in the U.K., AEG - Allgemeine Elektricitäts-Gesellschaft, ASEA -Allmänna Svenska Elektriska Aktiebolaget, to name but a few.

Up to this point in time, every country had developed in an identical manner and each had a variety of differently funded local and regional networks – generation, distribution and some limited transmission – with low capacity and by today's standards, at low voltage levels.

There was, however, a natural barrier to further development; the point at which it became un-economic to expand further and no country developed an all-encompassing national grid.

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There were several different solutions to this *impasse* adopted by different countries depending on their circumstances, ideology, and political leanings. In France, the industry was nationalised in 1946 and EdF was formed; in the U.K. the entire industry was nationalised in 1948 and the CEGB was formed; in Italy ENEL was formed; in Portugal EDP; in Spain ENDESA; in Ireland ESB, and so on. These are all examples where one nationalised entity was set up with a monopoly – or near monopoly – on generation, transmission and distribution. Similarly, in most of Eastern Europe and the former Soviet Union, monopolistic structures were a way of life and this equally applied to the electricity supply industry. And globally, there are many other examples around the world of governmental control of the industry, either from the inception of the industry or during the growth period during the 1950s and 1960s. One of the major benefits of this monopoly structure, whether it be for ideological or for purely practical reasons, has been that with one organisation, central planning and government assistance with funding enabled grid development for the national good – even if there is no immediate prospect of a return on the capital investment.

There were other variations on this theme based on regional monopoly status, an example of which are Japan with 10 EPCOs, Malaysia with three separated states and Australia with seven regional organisations. And there are other variations favoured in some Northern European countries that evolved regional umbrella organisations whilst retaining local distribution companies, an example of which is Germany with four regional structures and 350 distributors; and on a smaller scale Denmark with a similar structure.

Again, the common theme is one of encouraging grid development by facilitating funding and/or underwriting investment.

2. The USA experience

The USA is not a country where government involvement in business is tolerated, expected or indeed encouraged; and this has been by and large the case in the grid development. The development pattern was similar to that described earlier, with some state-by-state assistance as isolated networks grew and merged, but even allowing for the geographical size of the country, there are still in the order of 3,000 utility organisations in the country.

National coordination was slow to develop and NERC – the National Electric Reliability Council, as it was then titled, was only formed as a voluntary organisation in 1968.

A federal organisation – the Federal Electric Research Council has roots going back to 1920, when Congress established the Federal Power Commission (FPC) to coordinate hydroelectric projects under federal control. Under the joint administration of the Secretary of War, Interior, and Agriculture, the FPC could only employ an Executive Secretary, while all other personnel were borrowed from these administrating executive departments. This organization resulted in conflicting mandates, making it difficult to produce a consistent energy policy. Thus, in 1928 Congress voted to give the FPC funds to permanently hire their borrowed staff. Two years later, the Federal Power Act established a five-member, bipartisan commission to run the FPC.

This organisation expanded and by 1967 FPC was given jurisdiction over intrastate utilities if they connected their supply lines to others outside of the state. As a

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result of their expanded jurisdiction, the FPC became pivotal when there were chronic brownouts in the 1960s and the OPEC embargo in the 1970s. This called for reorganization of the FPC.

In 1977, Congress reorganized FPC as FERC (Federal Energy Regulatory Commission), and the responsibilities of the Commission continued to expand. Today, FERC is an independent agency that regulates the interstate transmission of electricity, natural gas, and oil. FERC also reviews proposals to build liquefied natural gas (LNG) terminals and interstate natural gas pipelines as well as licensing hydropower projects. As part of that responsibility, FERC:

- *Regulates the transmission and wholesale sales of electricity in interstate commerce;*
- *Reviews certain mergers and acquisitions and corporate transactions by electricity companies;*
- *Regulates the transmission and sale of natural gas for resale in interstate commerce;*
- *Regulates the transportation of oil by pipeline in interstate commerce;*
- *Approves the siting and abandonment of interstate natural gas pipelines and storage facilities;*
- *Reviews the siting application for electric transmission projects under limited circumstances;*
- *Ensures the safe operation and reliability of proposed and operating LNG terminals;*
- *Licenses and inspects private, municipal, and state hydroelectric projects;*
- *Protects the reliability of the high voltage interstate transmission system through mandatory reliability standards;*
- *Monitors and investigates energy markets;*
- *Enforces FERC regulatory requirements through imposition of civil penalties and other means;*
- *Oversees environmental matters related to natural gas and hydroelectricity projects and other matters; and*
- *Administers accounting and financial reporting regulations and conduct of regulated companies.*

The U.S. faces three problems:

- aging infrastructure in general
- congestion at the interstate level
- changing power flows due to increased renewable generation

Based on the information compiled by the EIA (U.S. Energy Information Administration) from utility reports to FERC, filed by utilities representing about 70 % of the total U.S. electric load, those utilities spent about $21 billion on capital additions in 2016. Investment in transmission additions accounted for most utility transmission expenditures. In 2016, total transmission expenditures by utilities included in the FERC data reached $35 billion, with investment in transmission infrastructure making up 61 % of that total.

Capital investment accounts for the largest share of distribution costs as the U.S. utilities work to replace aging equipment. According to a 2015 U.S. Department of Energy report "Quadrennial Technology Review 2015", at that time 70 % of power transformers were at least 25 years old, 60 % of circuit breakers were 30 years or older, and 70 % of transmission lines were 25 years or older.

Many estimates have been put forward as to the total spend that will be necessary to modernize the T&D network of the U.S. and allow it to cope with the demands of decentralised generating facilities; the

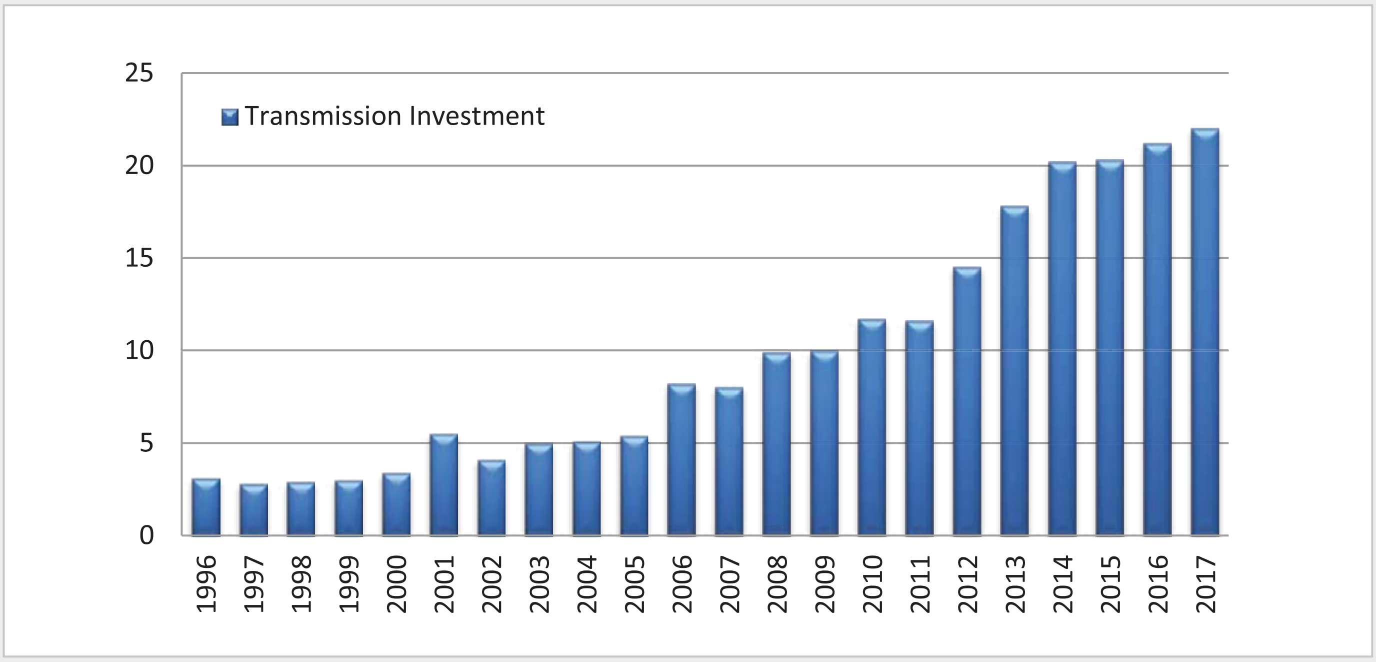

Figure 1. U.S. Transmission network investment (Source: Goulden Reports, from EIA data extracts)

consensus appears to be that an average expenditure approaching $30 billion p.a. will be necessary over the next decade and maybe up to as far as 2040.

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This is politely referred to as the "next investment cycle", but should more properly be referred to as the catch-up due to decades of underinvestment. It should not come as any great surprise that something was amiss; a quick glance at the shape of the curves in Figures 1, 2 and 3 shows the differences between them. Transmission investment did not rise above $6 billion in any year before 2006 and did not get above $12 billion until 2011, and similarly capital investment in the distribution network which was running at about $14 billion p.a. for the previous decade did not breach the $20 billion mark until 2008. Installed generating capacity meanwhile grew at over 5.0 % CAGR up to 1990, nearly 2.0 % CAGR in the period from 1990-2010 and 2.5 % between 2000 and 2010.

There will always be some degree of lead and lag between generating capacity and the capability of the grid to transmit and distribute the generated electricity – and indeed in the other direction when reserve generating capacity is compromised by peak demand, but the ramifications of turning on and off the investment tap

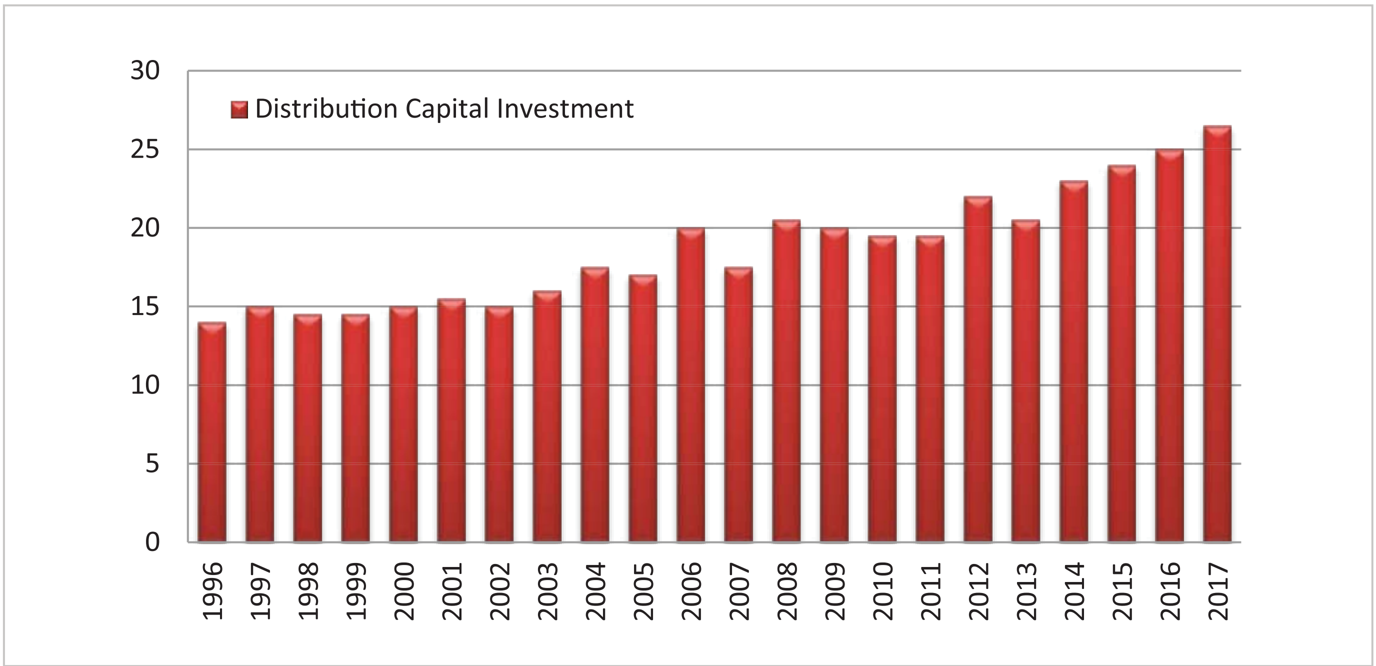

Figure 2. U.S. Distribution costs and capital investment (Source: Goulden Reports, from EIA data extracts)

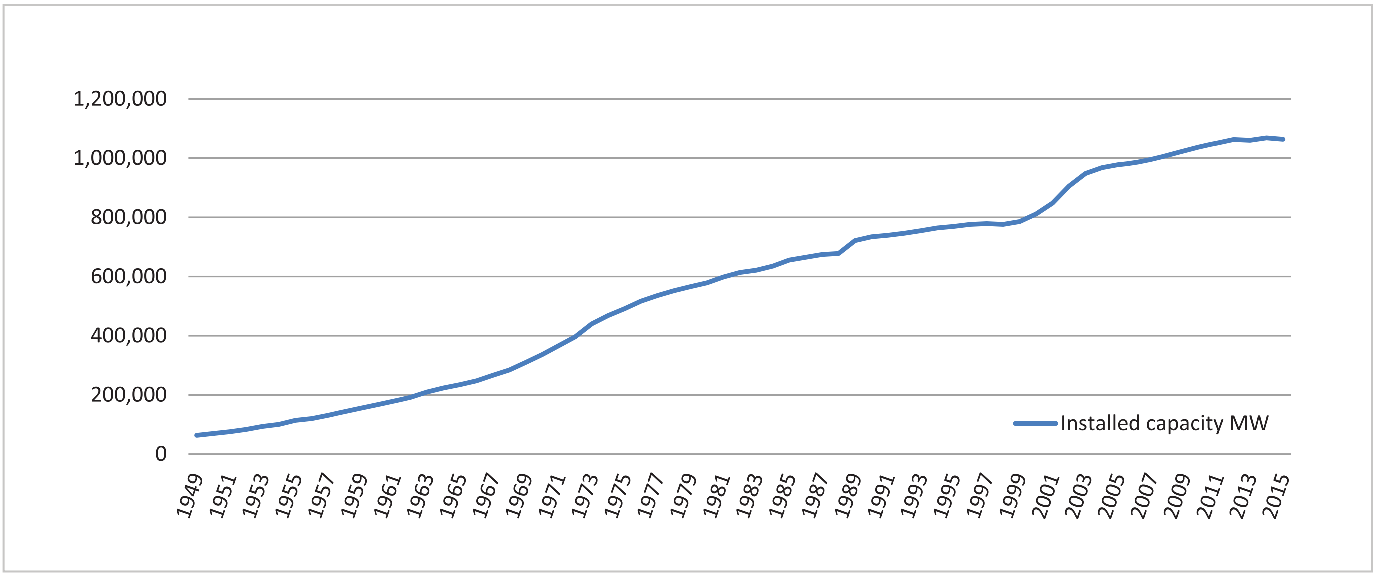

Figure 3. U.S. Installed capacity from 1949 to 2015

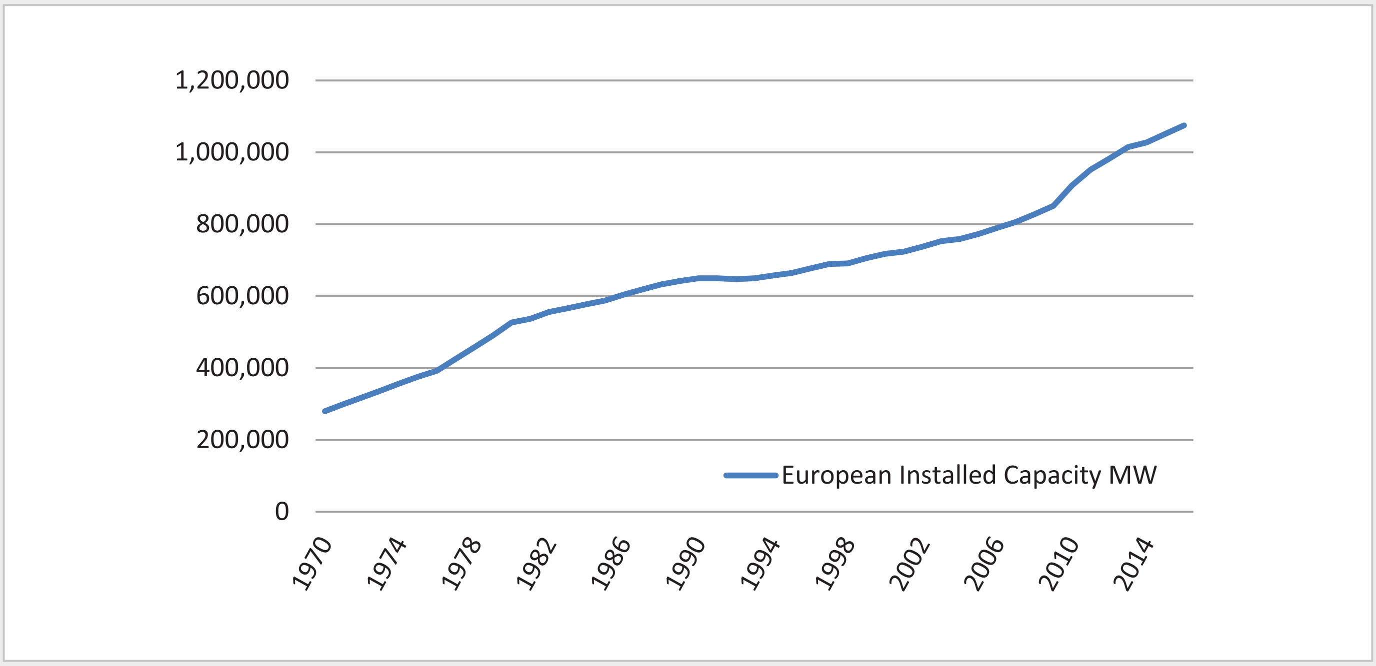

Figure 4. European installed capacity 1970-2014 (Source: Goulden Reports analysis of UN statistics)

> **The Europeans have followed a smoother grid development path, and generally, they have newer kit and have better supported their manufacturing base**

are far reaching. A power transformer fleet in which 70 % are more than 25 years old impacts and has impacted the manufacturing industry. This statistic means that only 30 % of the fleet has been installed since 1990 when George H.W. Bush was one year into his presidency. Furthermore, the dearth of orders for very large transformers resulted in the U.S. losing the ability to supply these machines and by 2010 most were imported. The situation has improved a little since that time, but it is noticeable that the first three plants in the U.S. to produce these were built by EFACEC of Portugal, Hyundai of South Korea and the Japanese giant Mitsubishi.

3. The European experience

As noted earlier, most European countries opted for direct government involvement in order to complete the development of a national grid system; this especially aided a more smooth development during the early years of grid expansion. In the U.K. the industry was gradually privatised during the 1990s; the company National Grid was established in 1990 and the CEGB was not formally dissolved until 2001.

It is worth noting that the first directive from the European Union starting the process of electricity market liberalisation was in 1996. Progress has been slow and patchy since then. Most countries have accepted the principle of competitive privately owned and operated generating companies and a grid operated by a (or several) TSOs (Transmission System Operators), ensuring equal access to the grid network for competing generators, distributors and other customers. However, the question of private company ownership of the grid is not universally accepted throughout the 28 EU nation states. The U.K. and Germany have by and large accepted the fact that a privately owned, operated and maintained grid can work – albeit in a heavily regulated way. Other countries, such as the Nordic area containing Norway, Sweden, Finland and Denmark, participate in a pool system part owned and operated by four privatised TSOs, although most of the share capital is still in state hands.

France has "privatised" EDF and the subsidiary TSO – the RTE, but the share capital is still 83.7 % government owned. And the list goes on: Portugal, Spain, Italy, Greece, etc. have all continued with state ownership of the TSO grid company. In these countries the financing for the expansion and adequacy of the national grid system has remained since inception a state government activity.

The overall point is that much of the grid development throughout Europe over the period from 1960 through to 2015 had been completed within the remit of government control and financing arrangements. As can be seen from Figure 4, the installed capacity (and by inference the grid development) has followed a similar path to that in the USA.

As each country developed through this century, the emphasis was introspective, but increasingly, countries increased their dependence on exchanges of power to augment and balance their own national requirements. Greater international cooperation and coordination was required and in 2008 ENTSO-E (the European Network of Transmission System Operators for Electricity) was formed. The stated aim of the organisation is:

"ENTSO-E, the European Network of Transmission System Operators, represents 43 electricity transmission system operators (TSOs) from 36 countries across Europe. ENTSO-E was established and given legal mandates by the EU's Third Legislative Package for the Internal Energy Market in 2009, which aims at further liberalising the gas and electricity markets in the EU."

In practice, ENTSO helps coordinate development plans, collects and collates market data, and guides individual TSOs in policy formation. It is noteworthy that the EU comprises 28 nation states and ENTSO-E has 36 country members, and whilst it aims to liberalise the markets, a glance at the 46 organisations on the membership list shows that the majority are not privatised.

Conclusion and future prospects

Nevertheless, it has to be said that there are many similarities in the role that ENTSO-E plays in Europe and that which FERC plays in the U.S. The two blocs have ended up at the same point in time with a broadly similar network and are facing similar challenges into the future. It could be argued that the Europeans have followed a smoother path – certainly there have been no catastrophic widespread outages, and generally the Europeans have newer kit and have better supported their manufacturing base. But looking into the future, the next development stage has yet to unfold. Investment is happening in the U.S. and at unprecedented levels; meanwhile in Europe, where there is a regulated environment and limitations are placed on the returns that TSOs can make, these rules are being relaxed in order to allow large capital projects to go ahead. Following the crash of 2008, governments have found it difficult enough to balance their books without providing additional help for infrastructure development. Some have even been asked to think the unthinkable and raise capital by selling state-owned assets. But who would want to buy and run a heavily regulated monopolistic organisation in say Italy or Portugal, for instance? It would appear that this prospect is of interest to the Chinese – a trend that is unlikely to gain any traction in the U.S., but then again, those assets are not up for sale. The next 20 or 30 years will be interesting on both sides of the Atlantic.

Author

Steve Aubertin is the Managing Director of Goulden Reports and following a first career in electrical engineering has spent the last 30 years researching and reporting on the global market for electrical products in both published and in the form of tailored research for specific clients.